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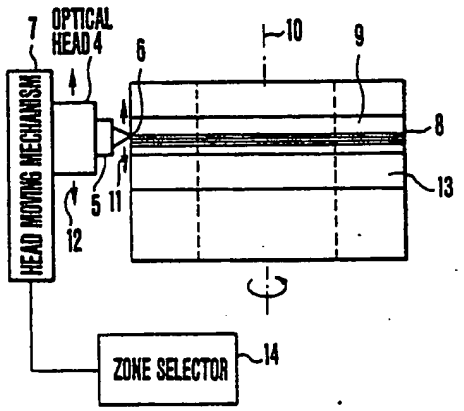
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(54) Optical memory device and information processing apparatus.

(57) An optical memory device comprises a cylindrically-shaped optical information recording medium (1) and at least one optical head (4) disposed around the information recording medium for irradiating information recording medium with a light spot (6) for recording or reproduction of information. The optical head has light spot moving means (20, 21) incorporated therein for the irradiation position of the light spot. The recording or reproduction of information is made by causing the light spot moving means to perform a tracking control so that the light spot follows a desired track in an area within a range of movement of the light spot by the light spot moving means (or an information recording zone) in a state in which a relative positional relationship between the optical head and the cylindrically-shaped information recording medium in a direction parallel to the direction of a rotation axis (10) of the information recording medium is fixed with the optical head being not moved. The device can be constructed so that the position of one of the optical head and the cylindrically-shaped information recording medium relative to the other in the direction parallel to the direction of the rotation axis of the information recording medium is mechanically moved, thereby making it possible to turn an information recording zone (9) in the range of movement of the light spot by the light spot moving means into another information recording zone (13).

FIG.1b



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OPTICAL MEMORY DEVICE AND INFORMATION PROCESSING APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to a small-sized and high-performance optical memory device suitable for use in a small-sized computer such as a portable computer, and more particularly to a small-sized optical memory device the access speed and data transfer rate of which are faster than those of the conventional magnetic memory.

A file memory higherto used for a small-sized portable computer such as a laptop computer includes a fixed magnetic disk, a floppy disk, etc. However, these file memory devices involve great problem pertaining to performances thereof. A first problem is concerned with the fact that a distance between a magnetic head and a recording medium is very small in the case of the magnetic memory. More particularly, when the magnetic memory device is used in a strongly vibratory condition as in a portable computer, the destruction of data may be caused by the touch of the recording medium with the magnetic head or the like, thereby deteriorating the reliability. A second problem lies in that an increasing demand for the improvement of a memory capacity will result in the increase of the size of the memory device and hence the increase of the size of the file apparatus. A third problem lies in that it is very difficult to greatly shorten an access time. This is because in the case of the magnetic memory the magnetic head must be mechanically moved by large strokes.

SUMMARY OF THE INVENTION

An object of the present invention is to solve the above-mentioned problems of the conventional memory device or to provide a small-sized and high-performance optical memory device which enables fast access and fast data transfer.

Another object of the present invention is to provide a high-reliability optical memory device which has an excellent resistance against vibrations and can make a very stable operation even under a strongly vibratory condition of use as encountered in a portable computer or the like.

A further object of the present invention is to provide an information processing apparatus such as a laptop computer or a portable computer into which the above-mentioned intentive optical memory device can be incorporated as a package.

An optical memory device according to the present invention comprises a cylindrically-shaped rotating optical information recording medium and at least one optical head provided around the information recording medium for irradiating the information recording medium with a light spot for recording or reproduction of information, the optical head having light spot moving means incorporated therein for controlling the irradiation position of the light spot, the recording or reproduction of information being made by causing the light spot moving means to perform a tracking control so that the light spot follows a desired track in an area within a range of movement of the light spot by the optical spot moving means (or an information recording zone) in a state in which a relative positional relationship between the optical head and the cylindrically-shaped information recording medium in a direction parallel to the direction of a rotation axis of the information recording medium is fixed with the optical head itself being not moved.

As the light spot moving means can be used a lens actuator for mechanically moving a lens or a solid state deflector for electrically deflecting a light spot. The use of the solid state deflector is advantageous in view of fast access and miniaturization. The solid state deflector may include a deflector using an acousto-optic effect, a deflector using an electro-optic effect or a deflector using surface acoustic waves. The solid state deflector can deflect a light spot over a range of 0.5 to 1 mm for a time not longer than 10 μs. For example, when the diameter of the cylindrically-shaped recording medium is 20 to 50 mmϕ and the width of one information recording zone is 0.5 to 1 mm, the track pitch is in the order of 1 to 2 μm, the recording capacity per one track up to 4 to 20 KB is possible by pit edge recording, information of about 1 MB to 20 MB can be recorded in one information recording zone and the information of 1 to 20 MB can be seeked at a high speed not longer than 10 μs. On the other hand, the speed of rotation of the cylindrically-shaped recording medium is in the order of 3600 to 10000 rpm and the data transfer rate is 0.24 to 3.3 MB/s. According to the present invention, information of about one megabyte (MB) to several-tens megabytes (MB) can be recorded in one information recording zone. Namely, one information recording zone corresponds to one floppy disk or one magnetic disk conventionally used. Access to any track in the recording zone can be made by merely moving a light spot by means of the light spot moving means in a state in which the optical head itself is not moved or is fixed. Therefore, access faster than the conventional magnetic memory is possible. The optical memory device has an excellent resistance against vibrations and hence the device can stably operate even under a strongly vibratory condition

as encountered in a portable computer or the like. Also, since the optical information recording medium is formed on a surface of the cylinder, the recording medium is free of any warp as involved by a disk medium and hence a focusing control of the light spot and the control of the position of the light spot relative to a track (or a tracking control) are easy, thereby making it readily possible to increase the speed of rotation up to 6000 to 10000 rpm and hence to increase the data transfer rate.

The optical memory device can be constructed so that the position of one of the optical head and the cylindrically-shaped information recording medium relative to the other in a direction parallel to the direction of a rotation axis of the recording medium is mechanically moved, thereby turning an information recording zone in the range of movement of the light spot by the light spot moving means into another information recording zone. Accordingly, a plurality of information recording zones can be provided on the cylindrically-shaped information recording medium. Since information of about one megabyte to several-tens megabytes can be recorded in one information recording zone as mentioned above and several to several-tens information recording zones can be provided, information of several megabytes to several-hundreds megabytes can be recorded in or reproduced from one cylindrically-shaped recording medium. Any one of the information recording zones can be selected by a zone selecting mechanism. According to the present invention, the recording capacity can be increased by merely increasing the number of information recording zones to be provided on the cylindrically-shaped recording medium. In other words, a small-sized and large-capacity optical memory device can be realized without making the size of the device itself considerably or substantially large. For example, with a drum-like recording medium having a diameter of 30 mm and a height of 10 mm, there is readily obtained a microoptical memory device which has a very small size not larger than 40 x 40 x 20 mm and the following performance: the recording capacity one drum is 100 MB, the recording capacity per one information recording zone is 10 MB, the number of information recording zones is 10, the number of revolutions (or the speed of rotation) is 7200 rpm, the data transfer rate is 1.2 MB/s, the mean access time is not longer than 1 ms and the seek time is 10 μs.

Also, the optical memory device according to the present invention can be installed or incorporated as an optical memory package into an information processing apparatus such as a laptop computer or a portable computer. An information processing apparatus according to the present invention is constructed so that the above-mentioned optical memory device can be installed as a package. The information processing apparatus includes components necessary for driving and controlling the optical memory device, for example, a rotating mechanism for rotating the cylindrically-shaped information recording medium of the optical memory device, a moving mechanism (or zone selecting mechanism) for moving the optical head of the optical memory device, a signal processing circuit connected to the optical head for performing a signal processing for the recording or reproduction of information and the positional control of a light spot including a focusing control and a tracking control, and a controller for driving and controlling the above-mentioned components.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1a and 1b are plan and side views showing an embodiment of an optical memory device according to the present invention;

Fig. 2 is a view showing an embodiment of an optical head used in the present invention;

Fig. 3 is a view showing another embodiment of an optical head used in the present invention;

Fig. 4 is a view showing an embodiment of an optical head moving mechanism used in the present invention;

Fig. 5 is a view showing another embodiment of an optical memory device according to the present invention;

Fig. 6 is a view showing a further embodiment of an optical memory device according to the present invention; and

Fig. 7 is a view showing an embodiment of an information processing apparatus according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figs. 1a and 1b show in plan and side views an embodiment of an optical memory device according to the present invention. A cylindrically-shaped information recording medium 1 has an information recording film 2 provided on the surface of a cylindrical substrate and is rotated by a motor 3 in a direction indicated by arrow. As required, the information recording medium 1 is provided with a transparent substrate having a guide track (groove or pre-pit train) formed thereon for guiding along a track a light spot with which the information recording film 2 is to be irradiated, and a protection film for protecting the information recording film 2 formed on the transparent substrate. The speed of rotation of the information recording medium 1 is

usually 3600 to 10000 rpm but may be arbitrary. In order to increase the data transfer rate, the speed of rotation is preferably not smaller than 6000 rpm. Since the recording medium is formed on the surface of the cylindrical substrate, the recording medium is free of any warp as involved by a disk medium. Therefore, a positional control of the light spot is easy and hence the speed of rotation of the recording medium can be easily increased. As the information recording film can be used many kinds of recording films including write-once type recording film in which information can be written only once and a rewritable or erasable recording film in which information can be rewritten. Typical examples of the write-once type recording film include a Te-Se system chalcogen material, an organic dye material and a phase change material using a phase change between a crystalline state and an amorphous state. Typical examples of the rewritable or erasable recording film include an optomagnetic recording material and a phase-change recording material. In a state in which the cylindrically-shaped information recording medium 1 is rotated, the recording or reproduction of information is made by means of an optical head 4. A lens 5 is provided at the tip of the optical head 4 and a small light spot 6 is formed on the information recording film 2 by means of the lens 5. The small light spot 6 with which the rotating information recording film 2 is irradiated can be moved in a direction parallel to a rotation axis 10 of the cylindrically-shaped information recording medium 1 or in a direction of arrow 11 with the optical head 4 itself being not moved. Thereby, the recording or reproduction of information along a desired track 8 on the information recording film 2 is effected while making a tracking control. A multiplicity of tracks 8 are formed in an area of an information recording zone 9. The small light spot 6 is arbitrarily moved in that area with no movement of the optical head 4 so that the recording or reproduction of information is effected in the information recording zone. In the recording zone 9, access to any track is made by merely moving the light spot by a light spot moving means incorporated into the optical head 4 with the optical head 4 itself being not moved or being fixed. Therefore, the width of the information recording zone is selected to fall within a range of movement of the light spot by the light spot moving means. If a solid state deflector is used as the light spot moving means, the deflection of the light spot in a range of 0.5 to 1 mm can be made at a high speed not longer than 10 μs. When the diameter of the cylindrically-shaped information recording medium 1 is 20 to 50 mmϕ and the width of one information recording zone 9 is 0.5 to 1 mm, information of about 1 MB to 20 MB can be recorded in one information recording zone and the information can be sought at a high speed not longer than 10 μs. Namely, one information recording zone corresponds to one floppy disk or one magnetic disk conventionally used and access to any track 8 in the information recording zone can be made at a very high speed by merely moving the light spot by means of the light spot moving means with the optical head 4 itself being not moved or being fixed. The optical head 4 can be moved in a direction of arrow 12 by an optical head moving mechanism 8. The amount of movement of the optical head 4 at that time is substantially equal to the range of movement of a light spot by the light spot moving means or greater than that. By thus making the large movement of the optical head 4 by use of the optical head moving mechanism 7, the information recording zone 9 in which the recording or reproduction of information is being made by only the movement of the small light spot can be turned into another zone 13. In this manner, a plurality of information recording zones can be provided on the cylindrically-shaped information recording medium 1. User information of about one megabyte to several-tens megabytes can be recorded in one information recording zone. Since several to several-tens information recording zones can be provided on the cylindrically-shaped information recording medium, it is possible to record or reproduce information of several megabytes to several-hundreds megabytes in or from one cylindrically-shaped information recording medium. Also, any one of the information recording zones can be selected by driving and controlling the optical head moving mechanism 7 by means of a zone selector 14.

Fig. 2 shows an embodiment of the optical head 4 used in the present invention. A laser beam 15 emitted from a semiconductor laser 140 is passed through a collimator lens 16 to provide a collimated beam which in turn is focused as a small light spot 6 on an information recording film 2 by a lens 5. A reflected beam from the information recording film is separated by a beam splitter 17 and passed through a lens 18 and thereafter impinges upon a photo detector 19 which in turn detects a signal. The small light spot 6 moves in a direction of arrow by mechanically moving the lens 5 by a lens driving mechanism 20. With such a movement of the small light spot, the recording or reproduction of information in or from any track position in an information recording zone is effected while causing the small light spot to follow a track.

Fig. 3 shows another embodiment of the optical head 4 used in the present invention. In a manner similar to the case of Fig. 2, a laser beam 15 emitted from a semiconductor laser 140 is introduced onto an information recording film 2 by a

lens 5 so that a small light spot 6 is formed on the information recording film 2. The laser beam 15 is deflected by a solid state deflector 21 so that the small light spot 6 is moved on the information recording film 2 in a direction indicated by arrow. The solid state deflector 21 may include a deflector using an acousto-optic effect, a deflector using an electro-optic effect, or the like. In the case where the solid state deflector using the acousto-optic effect is employed, the movement of the small light spot is effected by changing the frequency of acoustic waves in accordance with the desired amount of movement of the small light spot. In the case where the solid state deflector using the electro-optic effect is employed, the movement of the small light spot is effected by changing a voltage applied to the deflector. By using such solid state deflectors, it is possible to perform the movement of the small light spot at a high speed.

Fig. 4 shows an embodiment of the optical head moving mechanism 7 used in the present invention. An optical head 4 is supported by a feed guide shaft 22 inserted into a through-hole 25 of the optical head. A feed screw 24 inserted in a threaded feeder 26 is rotated by a feed motor 23 so that the optical head 4 is mechanically fed as a whole in a direction indicated by arrow. The amount of feed of the optical head 4 is selected to be substantially equal to an information recording zone determined by the amount of movement of a small light spot or greater than that. In this manner, the turn-over of information recording zones into each other can be made. The moving mechanism 7 is not limited to the method using the feed screw but may be any known method using, for example, a linear motor or a wire. In the shown embodiment has been employed a structure in which the optical head 4 is moved. Alternatively, the cylindrically-shaped information recording medium 1 may be moved with the optical head 4 being fixed.

Fig. 5 shows another embodiment of an optical memory device according to the present invention, in which a plurality of optical heads are used. Four optical heads 4-1, 4-2, 4-3 and 4-4 are arranged around a cylindrically-shaped information recording medium 1 and at positions where the cylinder is equally divided. These optical heads include lenses 5-1, 5-2, 5-3 and 5-4 and head moving mechanisms 7-1, 7-2, 7-3 and 7-4, respectively. The positions of the optical heads can be simultaneously or independently moved by the head moving mechanisms. In the case where the four optical heads are simultaneously moved, the optical heads are placed on the same information recording zone. The effect of the arrangement of the plurality of optical heads is demonstrated when access to specified information in the information recording zone upon recording or reproduction is to be made. Namely, in the case where access to specified information is to be made, there is usually required a wait including a time for positioning a small light spot onto a specified track where the specified information is to be recorded or is recorded and a time until a specified location on the track or circumference where the information is to be recorded or is recorded is reached through rotation. This wait is an access time. In the present embodiment, the wait time for positioning onto the specified track is very short since the small light spot is moved by the movement of the lens or by the solid state deflector with the optical head itself being not moved, as has already been mentioned. The wait time for rotation is relatively long in the case where one optical head is used. However, in the case where a plurality of optical heads are used as in the present embodiment, the wait time for rotation can be shortened by the number of the optical heads. For example, when the speed of rotation of the cylindrically-shaped information recording medium 1 is 7200 rpm, 8 ms is required for one rotation and hence the mean wait time for rotation per one optical head in the case of the four-head arrangement is 1 ms. When the solid state deflector is used for movement of the small light spot, the wait time for positioning onto the specified track is usually not longer than 100 μs. Therefore, the total access time including the wait time for rotation is about 1 ms. Namely, much faster access as compared with the case of the conventional fixed magnetic disk is attainable. Various methods can be considered for selecting any one of the four optical heads. One method includes positioning the four optical heads simultaneously onto the same track, reproducing a sector address from each optical head, and selecting one of the four optical heads which is positioned in front of a target sector and nearest to the target sector.

Another advantage obtained by using the four optical heads lies in that the information recording or reproduction speed can be greatly enhanced by placing the four optical heads on different tracks respectively so that information are simultaneously and parallely recorded or reproduced.

Fig. 6 shows as a further embodiments of the present invention the structure of a small-sized optical memory package into which a cylindrically-shaped information recording medium and optical heads are incorporated. A small-sized optical memory package 27 includes a cylindrically-shaped information recording medium 1, an information recording film 2, a rotating motor 3, and optical heads 4-1, 4-2, 4-3 and 4-4. The four optical heads are mechanically fixed to each other so that the positions thereof relative to the cylindrically-shaped information recording medium can be simultaneously moved. For that purpose, a connection

portion 28 for a moving mechanism is used. When the present package is installed into an information processing apparatus such as a portable computer, each head is connected through a contact to an information processing circuit in the information processing apparatus and the connection portion 28 is connected to a moving mechanism preliminarily prepared in the information processing apparatus. It is not necessarily required that the rotating motor 3 is provided in the package 27. A motor preliminarily prepared in the information processing apparatus may be used. By thus preparing the information processing circuit and the moving mechanism, it is possible to make the optical memory package 27 very small. For example, when a drum-like recording medium having a diameter of 30 mm and a height of 10 mm is used, there is obtained an optical memory package which has a very small size not larger than 40 x 40 x 20 mm and the following performance: the recording capacity per one drum is 100 MB, the recording capacity per one information recording zone is 10 MB, the number of information recording zones 10, the speed of rotation is 7200 rpm, the data transfer rate is 1.2 MB/s, the means access time is not longer than 1 ms and the seek time is 10 μs.

Fig. 7 shows a still further embodiment of the present invention the construction of an information processing apparatus into which the above-mentioned small-sized optical memory package 27 is adapted to be installed. An information processing apparatus 29 includes therein a motor 30 for rotating a cylindrically-shaped information recording medium of the small-sized optical memory package 27 to be installed, a moving mechanism 31 for moving an optical head of the optical memory package, a signal processing circuit 32 connected to the optical head for performing a signal processing, a signal processor 34, an interface 33 for connecting the signal processor 34 and the signal processing circuit 32 with each other, a controller 35 for driving the small-sized optical memory package 27 by a signal from the signal processor 34, a display 36 connected to the signal processor 34, a data input part 37 such as a keyboard, etc. The very small-sized optical memory package 27 installed into the information processing apparatus 29 is used as a medium-exchangeable or fixed external memory.

As has been mentioned above, the use of a small-sized optical memory device, a small-sized optical memory package and an information processing apparatus according to the present invention realizes a very small-sized and large-capacity memory device which has a much faster access speed than the conventional fixed magnetic disk, floppy disk and optical disk. Also, the recording and reproduction of information are made optically, it is possible to make a distance between an optical head and an information recording medium greatly large, thereby realizing a high-reliability external file memory which can make a very stable operation even under a strongly vibratory condition as encountered in a portable computer or the like.

Claims

1. An optical memory device comprising:
an information recording medium (1) which has a recording film (2) provided on the surface of a cylinder and in or from which information is recorded or reproduced along a track extending in a direction of the circumference of the cylinder; and
an optical head (4) disposed around said information recording medium for irradiating the rotating information recording medium with a light spot (6), said optical head having light spot moving means (20, 21) for moving the light spot in a direction substantially perpendicular to a direction of the track in a state in which the position of one of said optical head and said information recording medium relative to the other in a direction parallel to the direction of a rotation axis (10) of said information recording medium is maintained, information being recorded or reproduced while causing the light spot to follow the track in a range of movement of the light spot by said light spot moving means.

2. An optical memory device according to Claim 1, wherein an area within said range of movement of the light spot by said light spot moving means is defined as one information recording zone (9, 13) of said information recording medium.

3. An optical memory device according to Claim 2, wherein said information recording medium includes a plurality of said information recording zones.

4. An optical memory device according to Claim 3, further comprising a moving mechanism (7) for changing the position of one of said optical head and said information recording medium relative to the other so that one of the information recording zones with which the light spot from said optical head is irradiated is turned into another information recording zone.

5. An optical memory device according to Claim 1, wherein said light spot moving means includes a solid state deflector (21).

6. An optical memory device according to Claim 1, wherein a plurality of said optical heads (4-1, 4-2, 4-3, 4-4) are disposed at positions where the periphery of said information recording medium is equally divided.

7. An optical memory device according to

Claim 3, wherein the recording capacity per one information recording zone is about one megabyte to several-tens megabytes.

8. An information processing apparatus into which an optical memory device according to any one of Claims 1 to 7 is adapted to be installed as a package, said information processing apparatus including a rotating mechanism (30) for rotating the information recording medium of the optical memory device, a moving mechanism (31) for moving the optical head of the optical memory device, a signal processing circuit (32) connected to the optical head of the optical memory device for performing a signal processing for the recording or reproduction of information and a positional control of the light spot, and a controller (35) for controlling said rotating mechanism, said moving mechanism and said signal processing circuit.

9. An optical memory device comprising an information recording medium for recording information therein and an optical head for focusing a laser beam as a light spot onto said information recording medium to record or reproduce information along a track, in which as said information recording medium is used a cylindrically-shaped rotating information recording medium (1), at least one said optical head (4) is disposed around said cylindrically-shaped information recording medium, said optical head includes light spot moving means (20, 21) for moving the light spot in a direction substantially perpendicular to a direction of the track with said optical head itself being not moved, the recording or reproduction of information is made by causing said light spot moving means to perform a tracking control so that the light spot follows the track in an area (9, 13) within a range of movement of the light spot by said light spot moving means, and the position of one of said optical head and said cylindrically-shaped information recording medium relative to the other in a direction parallel to the direction of a rotation axis (10) of said cylindrically-shaped information recording medium is mechanically changed.

10. An optical memory device according to Claim 9, wherein the amount of change of the position of one of said optical head and said cylindrically-shaped information recording medium relative to the other is not greater than the amount of movement of the light spot by said light spot moving means.

11. An optical memory device according to Claim 9, wherein the area within the range of movement of the light spot by said light spot moving means in said optical head is defined as one information recording zone of said cylindrically-shaped information recording medium.

12. An optical memory device according to Claim 11, wherein information recording zones are provided on said cylindrically-shaped information recording medium.

13. An optical memory device according to Claim 12, wherein a selecting function (14) for selectively using said information recording zones are provided.

14. An optical memory device according to Claim 9, wherein means (20) for mechanically moving the light spot is used as said light spot moving means in said optical head.

15. An optical memory device according to Claim 9, wherein an acousto-optic element (21) is used as said light spot moving means in said optical head.

16. An optical memory device according to Claim 9, wherein the position of one of said optical head and said cylindrically-shaped information recording medium relative to the other is mechanically changed by moving said optical head.

17. An optical memory device according to Claim 9, wherein a plurality of said optical heads (4-1, 4-2, 4-3, 4-4) are disposed at positions where the periphery of said cylindrically-shaped information recording medium is equally divided.

18. An optical memory device according to Claim 9, wherein an opto-magnetic recording material is used as said cylindrically-shaped information recording medium.

19. An optical memory device according to Claim 9, wherein a phase-change recording material is used as said cylindrically-shaped information recording medium.

20. An optical memory device according to Claim 9 installed into an information processing apparatus (29) which has a rotating mechanism (30) for rotating said cylindrically-shaped information recording medium.

FIG.1a

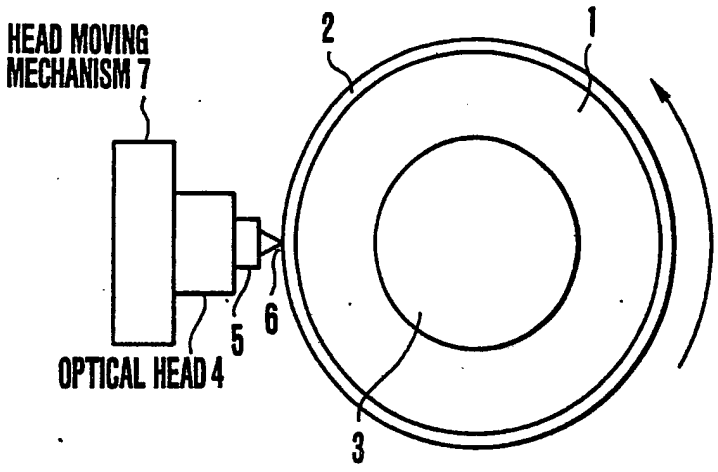

HEAD MOVING MECHANISM 7
2
1
5
6
OPTICAL HEAD 4
3

FIG.1b

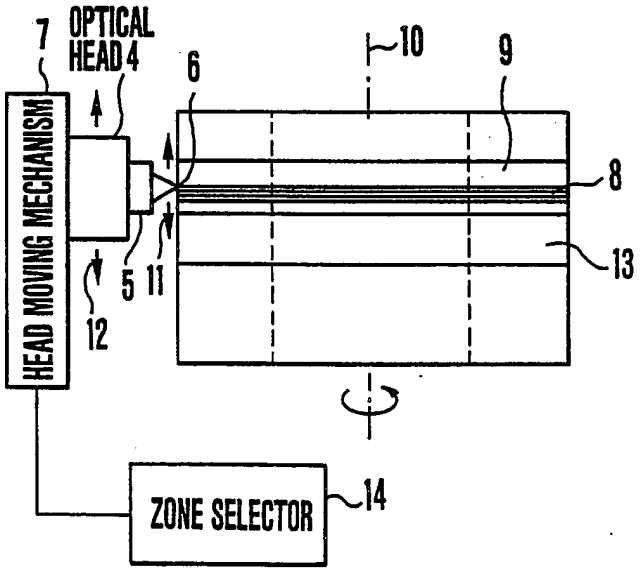

7
OPTICAL HEAD 4
6
10
9
8
HEAD MOVING MECHANISM
5
11
13
12
ZONE SELECTOR
14

FIG.2

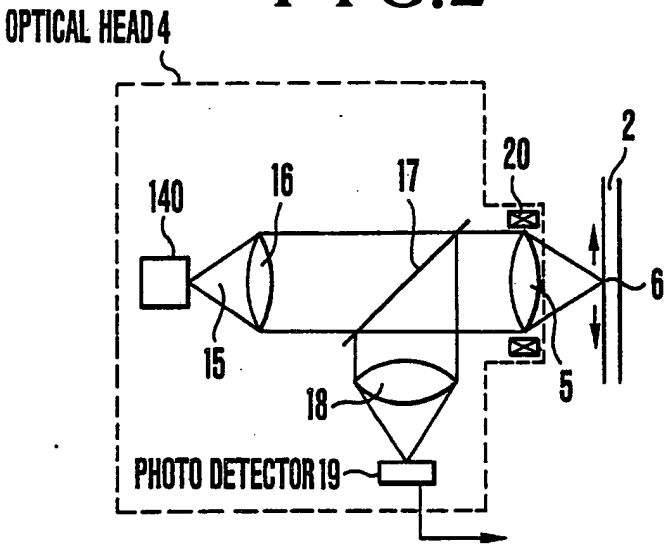

OPTICAL HEAD 4
140
16
17
20
2
6
15
5
18
PHOTO DETECTOR 19

FIG.3

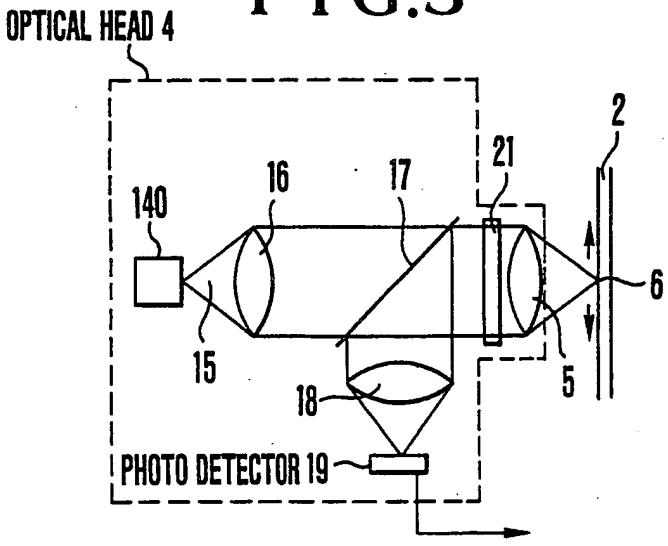

OPTICAL HEAD 4
140
16
17
21
2
6
15
5
18
PHOTO DETECTOR 19

FIG.4

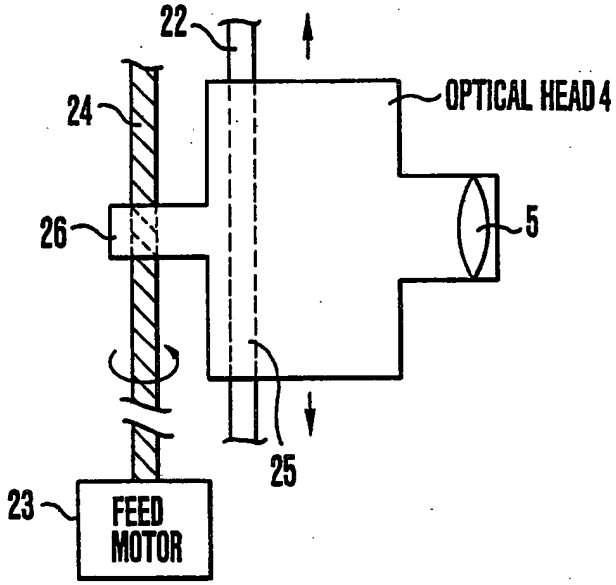

22
24
OPTICAL HEAD 4
26
5
25
23
FEED MOTOR

FIG.5

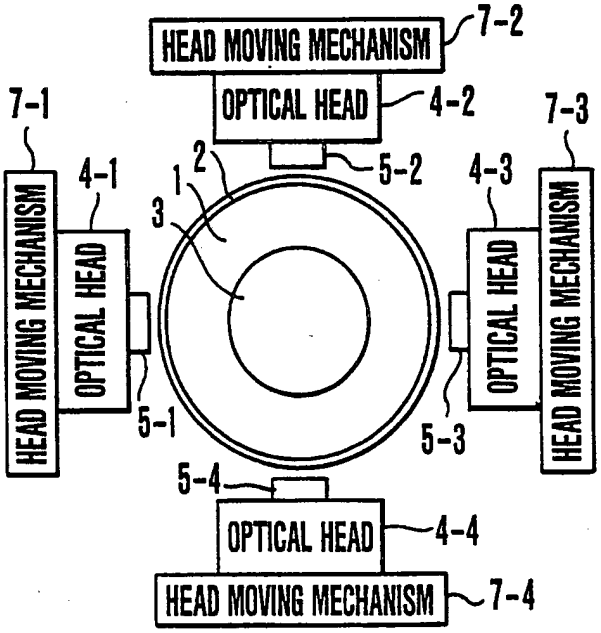

HEAD MOVING MECHANISM
7-2
OPTICAL HEAD
4-2
7-1
7-3
4-1
4-3
2
1
3
5-2
HEAD MOVING MECHANISM
OPTICAL HEAD
OPTICAL HEAD
HEAD MOVING MECHANISM
5-1
5-3
5-4
OPTICAL HEAD
4-4
HEAD MOVING MECHANISM
7-4

FIG.6

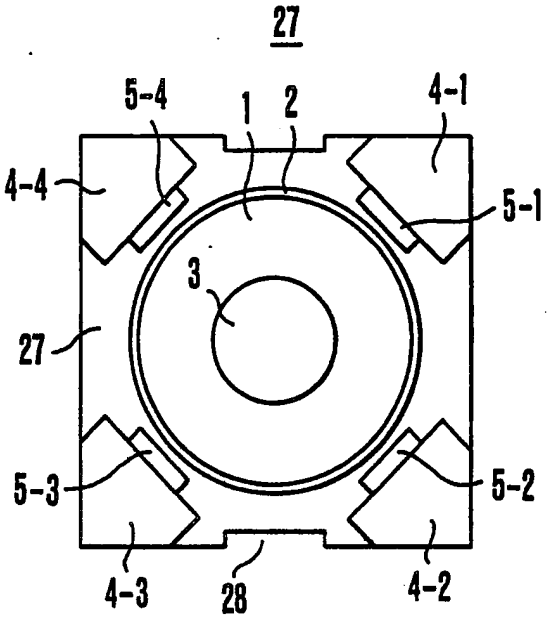
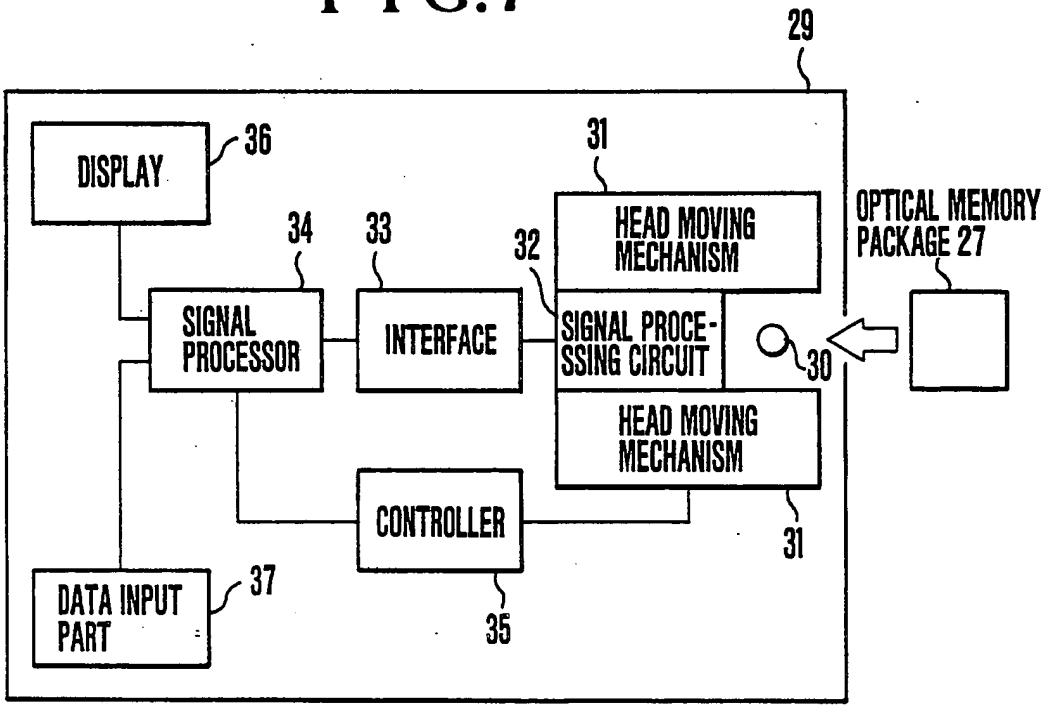

27
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1
2
4-1
4-4
5-1
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FIG.7


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